

# Invited Paper: The Stem Advisory Forum: A means of allowing people to influence the Government's STEM initiatives

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## Abstract

This paper gives a short overview of the UK government's STEM agenda and then considers one aspect in depth – the STEM Advisory Forum. It explains how the Forum operates to draw together views from across the STEM community through online discussions and face-to-face events. Four examples are given of topics that have been dealt with by the Forum. Firstly the topic of engineering, enrichment and engagement is covered through samples of various events and discussions. A major issue covered is the number of young people taking A Level mathematics. The background to the issue is explained and how views expressed on the Forum might have had some influence upon the Government's advanced level target and may yet impact on admissions behaviour in universities. A third short example of impact on the number of university places for STEM subjects is given and the piece finishes with an example of impact at local level in schools.

## Introduction

These reflections have been written in the days following the publication by the UK Government of its Schools White Paper 2010 entitled 'The Importance of Teaching' (Department for Education 2010). This white paper covers

more than the title suggests since it includes the newly elected government's intentions about the future of the school system, teaching and leadership, and the curriculum/assessment. The issue of STEM surfaces on a number of occasions, however, and reiterates central government support for mathematics and science. In Chapter 4 it says (see excerpt pictured below).

In many ways the challenges outlined above are similar to those which the UK – and virtually every other country – has grappled with over the last decade: to ensure a strong supply of scientists, technologists, engineers and mathematicians to underpin all aspects of the UK economy. The central problem has been associated with attracting young people into the physical sciences and no country we are aware of is having difficulties in attracting the young into the biological and medical sciences. Mathematics is an interesting case because in the last few years the situation, at least in England, has improved significantly (see below as follows).

The central importance of "the quality of teaching and hence of teachers" remains in the new Government's thinking but it is pleasing to see that there will be reviews of the curriculum. In the case of the physical

### **We will focus central government support on strategic curriculum subjects, particularly mathematics and science**

- 4.25 We will continue to provide additional support for the uptake of mathematics and the sciences. A strong national base of technological and scientific skills is essential to growth and employers continue to report shortages of these skills.
- 4.26 This deficit will be tackled by providing support to increase the number of specialist teachers in physics, chemistry and mathematics and to improve the skills of existing teachers. We need more specialist mathematics teachers in primary schools and will encourage and support schools in developing this specialism. We will support schools which offer students the chance to study GCSE physics, chemistry and biology as separate subjects by exploring how performance tables can reward this raising of aspirations. The teaching of A level further mathematics will be supported by funding initiatives such as the further mathematics support programme. We will also look at ways of supporting the in-depth study of physics. Already other organisations, for example the Physics Factory, are enabling more state school students to enjoy high-quality physics teaching. And we will initiate two new competitions with prizes for the best engineering projects from male and female students in state schools.

## Invited Paper:

# The Stem Advisory Forum: A means of allowing people to influence the Government's STEM initiatives

sciences we hope changes will make the subjects more attractive to young people, as well as being fit for purpose. Three specific government decisions taken in recent years have been especially important in changing the climate of STEM education:

- (a) An emphasis upon recruiting persons into STEM teaching and then offering all STEM teachers access to high quality continuous professional development (see the Foreword in this issue by Holman, 2011).
- (b) Placing great emphasis upon mathematics at all levels in the school system. The most impressive consequences of this are being seen in the annual 5-10% increases in the numbers of young people choosing to study mathematics and further mathematics post 16 (compulsory schooling) and this is considered below in more detail since the STEM Advisory Forum has played a role in this development.
- (c) Encouraging schools most strongly to offer biology, chemistry and physics as separate subjects at Key Stage 4 (GCSE). This switch away from more 'general' science at GCSE has seen numbers taking the three separate sciences reach 115,000 in summer 2010 and, with mathematics, has rebalanced slightly the overall curriculum more towards STEM.

Without doubt these changes have aided what one might call the academic end of the STEM spectrum but success in encouraging D&T is less obvious. Earlier this century

D&T had been a compulsory subject at Key Stage 4, along with mathematics and science but has since ceased to be so. An inevitable conclusion of this policy decision is now that fewer pupils in the 14 to 16 age range take part in D&T. The subject has a close alliance with engineering and the E in STEM is perceived at school level to be less worthy of direct promotion than triple science at GCSE, or mathematics at A Level. So there remains the stubborn challenge of engineering. Numbers entering university have effectively been constant for a generation (c.f. medicine, biology, psychology etc.) and few useful tools have been developed to alter the balance significantly. Sadly, this is despite the strenuous efforts of the professional bodies within engineering.

### The STEM Advisory Forum

The STEM Forum has spent much of its energy on the broad issues raised above but, in addition, it has looked at other more technical issues. The Forum arose from a report published by Government in 2006 entitled 'The Science, Technology, Engineering and Mathematics (STEM) Programme Report'. This report laid out a programme of actions – seventeen in all – to stimulate STEM both at schools and universities. The actions attacked various issues and ranged from establishing high level groups to set the strategic goals through improving teacher recruitment/CPD to specific target numbers at school for each STEM subject. One Action (Action 3)

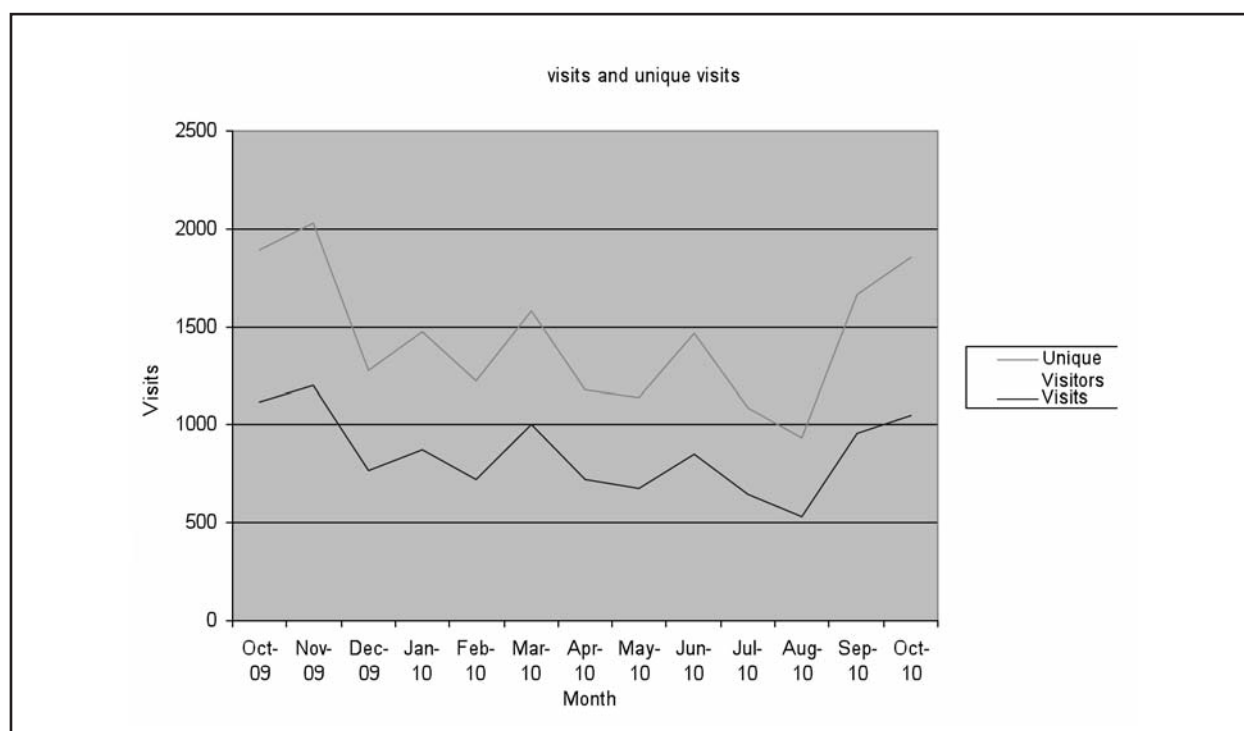


Figure 1. Summary of first level themes and second level shared perspectives

## Invited Paper: The Stem Advisory Forum: A means of allowing people to influence the Government's STEM initiatives

established 'A STEM Advisory Forum to ensure members of the wider STEM community can contribute their views and advice on policy formulation and delivery...'. The Forum is managed by NordAnglia on behalf of the Department for Education (the current contract ends on March 31, 2011) and we three, along with other friends and colleagues within a so-called Inner Circle, established a straightforward and cost effective model. It is built around two tools:

- The primary one is a website ([www.stemforum.org.uk](http://www.stemforum.org.uk)) which provides current news on STEM issues but with a main role of mounting questions on a regular basis, collecting together all comments on these questions, summarising the information which is then fed to government (the Department for Education (DfE) that is responsible for schools and the Department for Business, Innovation and Skills education (BIS) responsible for the universities). It is important to note that the specific questions mounted on the site arise from discussions between the 'Inner Circle' and reflect

government priorities: their specific wording is signed off by officials within DfE/BIS.

- In addition the Forum also holds regular face-to-face events to stimulate further debate on a specific topic. Again the results of these debates are placed on the website and reported to government.

Proving that the Forum influenced government policy is a difficult challenge but below we give some examples where the Forum may have had clear impact.

Although the STEM Advisory Forum website is publicly available ([www.stemforum.org.uk](http://www.stemforum.org.uk)) and the vast proportion of the material can be accessed freely there is a requirement to join the Forum in order to take part in an online discussion. Various numbers may give the reader give a sense of the website:

- Overall usage. There is a seasonality in the numbers of persons visiting the site as illustrated in Figure 1:
- The membership roster has increased from around 300 users when the site opened in 2008 to a current number of above 1000. This is an important statistic and

	Nov 09	Dec 09	Jan 10	Feb 10	Mar 10	Apr 10
Visits	1198	768	872	721	1001	722
Unique Visitors	833	509	602	502	580	456
New Visitors	642	380	468	413	463	351
Returning Visitors	556	388	404	308	538	371
Page Views	5166	3468	3374	2883	4901	2746
Average Session Time (MIN:SEC)	03:19	03:44	03:09	03:01	04:06	03:20
% change month on month (total visits)	7.54%	-35.89%	13.54%	-17.32%	38.83%	-27.87%
% change month on month (unique visits)	7.21%	-38.90%	18.27%	-16.61%	15.54%	-21.38%

	May 10	Jun 10	Jul 10	Aug 10	Sep 10	Oct 10
Visits	674	853	643	534	956	1046
Unique Visitors	468	616	447	397	706	806
New Visitors	373	503	370	328	226	690
Returning Visitors	301	350	273	206	131	356
Page Views	2436	3064	2891	2194	1501	4235
Average Session Time (MIN:SEC)	02:43	02:53	03:34	03:05	03:09	03:13
% change month on month (total visits)	-6.65%	26.56%	-24.62%	-16.95%	79.03%	9.41%
% change month on month (unique visits)	2.63%	31.62%	-27.44%	-11.19%	77.83%	14.16%

Figure 2. Breakdown of the people visiting the site during the last 12 months. About one half of the visitors each month are 'returners' with the other half being 'new visitors'

# Invited Paper:

## The Stem Advisory Forum: A means of allowing people to influence the Government's STEM initiatives

the rise indicates a widespread interest. Recently we attempted to categorise the 45 of our members who have posted comments on the most recent discussions. The proportions were 'membership bodies such as learned societies' – 22%; universities – 22%; business/industry – 18%; publicly funded bodies such as quangos/ local authorities – 15%; schools/further education – 11% and 'individuals' – 11%.

- One statistic that has concerned us relates to the number of members who are willing to post comments. In earlier years the numbers were often in single figures but recently they have risen to about 30. The Inner Circle has debated this at some length without coming to a firm conclusion. The degree of freedom to comment freely is strongly driven by one's employer and this might explain, for example, the strong reactions to a discussion on 'keeping STEM teaching up to date' as distinct to the discussion we held on university entrance preferences. Another possibility is that some of the comments require considerable thought and the issues are complex. This is the normal situation in educational matters and we suspect the task of preparing a thoughtful comment is relatively onerous and made slightly more so by the fact that virtually all posts are not made anonymously (c.f. see many comments posted on BBC and news media websites). We have offered anonymity to members posting but it has not been taken up to any great extent. Finally, as with other websites most visitors watch rather than participate.
- Over the last three years we have undertaken 25 discussions and held seven events. They are listed below, primarily to indicate the range of matters upon which the government wished us to consult. Much more detail including the government's responses are available on the website: [stemforum.org.uk](http://stemforum.org.uk)

### List of topics covered in the website discussions

- Primary specialist teachers
- STEM Ambassadors and STEM Teachers
- Increased numbers of students taking A Level and Further Mathematics
- How do we keep STEM in schools up-to-date and relevant?
- The future for the Post 16 Mathematics Landscape
- STEM at Key Stage 3 (11 to 14 year olds)
- ITT & Physics Teacher Shortage
- Progression of STEM in Further Education
- Science for all
- STEM CPD
- University Entry Preferences
- STEM Role Models
- Primary Curriculum in STEM subjects
- Science Examinations – Ofqual Reports

- Initial Teacher Training
- Teacher Retention
- Inter-disciplinary work – friend or foe to STEM?
- Triple Science
- Support for level 3 STEM subjects
- The supply of graduates in STEM subjects
- How well did England perform in PISA science?
- Advanced level Mathematics target
- Science and Society
- Science Diploma
- DCSF Action Programmes

### List of face-to-face events:

- Developing capability in pupils through Design and Technology and Engineering
- STEM Ambassador and Teacher discussion groups
- Mathematics and University Entry Preferences
- Primary Curriculum
- STEM at KS3
- Graduate Supply

### Four examples of website discussions/face-to-face events

#### 1. Engineering, enrichment and engagement

The first set of examples we would like to share with you relate to Engineering and Design and Technology and also to work in schools which brings STEM subjects together or which makes links with STEM roles in the world of work. Here are some samples of our work in this area:

Our first event in November 2008 focused on the supply of STEM Graduates (see below). At that event we considered the experience of learners pre-university. One of the inputs was from Matthew Harrison, Director of Education at the Royal Academy of Engineering; he shared with us work that the Academy was, and still is doing, to stimulate engagement in engineering in London schools. This work, focused on the engineering diploma, was clearly making a positive difference to pupils' attitudes and to inter-school collaboration.

Early in 2009 we hosted an online discussion on inter-disciplinary work in schools. All those who took part in the discussion were in favour of subject working together and were able to suggest a variety of benefits to learners. The strongest arguments were related to the authenticity of the experiences for pupils. The 'real world' does not come neatly packed into subjects; technical work in the field tends to draw on a range of disciplines. The point was made that Design and Technology is ideal for providing a context, with science and mathematics feeding in. We got an upbeat response from the DCSF to this discussion, with mention of the new secondary curriculum,



## Invited Paper: The Stem Advisory Forum: A means of allowing people to influence the Government's STEM initiatives

which had been implemented in the previous school term, and some positive comments about STEM clubs supported by STEMNET.

At our conference on the Primary Curriculum in summer 2009, Jane Turner – Deputy Director, SLC East of England and Gareth Pimley, former Assistant Chief Executive (Primary), the Design and Technology Association, gave a joint input on their two subjects. They gave a real sense of the excitement that can come from working across science and D&T in the primary phase. They expelled some myths about the then proposed new curriculum and explained the opportunities for meaningful and relevant connections to be made with the designed and made world. At the event and on the related website discussion there was almost unanimous support for integrating science and design and technology within a single programme of learning. Although most comments were positive, there were concerns that breadth of contexts for D&T might be reduced and that D&T could simply become a vehicle for demonstrating scientific ideas rather than a creative design subject in its own right. The DCSF in their response said that the position and teaching of D&T would be enhanced through its links with science.

Later in 2009 we had a discussion on 'STEM Role Models'. This was organised in collaboration with STEMNET who helped engage STEM Ambassadors in the debate. The discussion was packed with useful suggestions about things that STEM undergraduates and employees could do to help schools. There were interesting ideas on volunteers going into school to enrich the curriculum, and on getting pupils out of school. For example:

"Having worked in the Aerospace industry for several years, my experience was that getting young people into the factory onto the shop floor or in the design labs was the best way to engage them. They were just gob smacked with the hardware, the size, the noise, the complexity of what was going on all around them, and then finally showing them the finished article (an aircraft in my case) and letting them speak to other young people, either apprentices or new graduates."

The response from DfE on this discussion emphasised the importance of individual subjects. They also said that the department strongly supports volunteering in schools – both across STEM subjects and more broadly.

"This not only has benefits for students, teachers and schools as a whole, but also offer benefits to the individual volunteers and to the employers. Challenging stereotypes is vital to increasing the pool of young people attracted to STEM subjects and careers, and so aiding economic recovery."

The topic of links between industry and schools also came up in our two events and the on-line discussion on the Key Stage 3 age group. To quote one participant in this discussion:

"As an engineer and STEM ambassador with a significant involvement in the links between industry and education, I see these sort of activities as vital. Each time I go into a school or take part in an event, the value of showing students the relevance of their STEM learning in the world beyond school is clear to see. As a country, if we want to ensure a sufficient supply of good quality engineers and scientists, we have to take every opportunity to make sure students aware of the variety of work activities they could progress to, given the right STEM qualifications. The earlier in a student's life this starts the better too, in my opinion."

Again the DfE were supportive of these links in their response to these discussions:

"It is particularly heartening to hear how warmly the involvement of business and industry in schools has been received. It is businesses that need STEM skills so their involvement in education is entirely appropriate and very welcome."

Our most recent completed discussion was on the question: "How do we keep STEM in schools up-to-date and relevant?" This has been our most popular topic to date and many of the comments are from D&T teachers who are all aware that as engineering and manufacturing practices move on in the economy it is important that the school experience keeps pace. Our next event in Spring 2011 will focus on Engineering and D&T.

### 2. Mathematics and University Entry Preferences

One of the most encouraging STEM developments in recent years, arguably the most significant, has been the steady rise in the numbers of young people studying advanced level mathematics and further mathematics. We could speculate on the reasons behind this important continuing change. The most obvious contributory factors are the changes to the qualification itself. As part of curriculum 2000 changes to all A Level subjects, the criteria for A Level mathematics qualifications were changed. The context at the time was a loud call from many stakeholders to restore A Level mathematics to what it had been decades previously. In particular, there were calls from universities to re-introduce material into the cores that had been dropped in the past. These voices were listened to and the A Level was made much stiffer. The result was that the numbers of students taking A Level mathematics plummeted. Incidentally the complaints from

## Invited Paper:

# The Stem Advisory Forum: A means of allowing people to influence the Government's STEM initiatives

universities that students were not adequately prepared for their degree course did not cease, but they were somewhat drowned out by the chorus of complaint from many other universities that they were unable to recruit enough students. Some university mathematics departments during this period were close to closure.

Consequently there was an emergency revision to A Level mathematics alone. This revision retained the 'difficult' material from the core, but removed some optional material, slimming the total amount of content in the qualification. Both the drop from the 2000 revision and the subsequent recovery in numbers are visible in the graph. However, this does not entirely account for the increases. The numbers have more than recovered from pre-2000, levels and continue to rise. Another possible factor is the primary, *yes primary*, numeracy strategy (PNS). The young people who took A Level mathematics in 2006 had experienced just one year of the PNS when they were 11 years old. The 2007 cohort had two years of PNS and following on at secondary school they would have had some experience of the Secondary Mathematics Strategy. The 2008 cohort would have had three years of PNS and so on. Both Strategies were staffed at local authority level by consultants who provided the specialist and management support that schools needed to improve their teaching of mathematics. Although part of the Government's school improvement programme, rather than the STEM Programme, they had a significant impact on mathematics teaching and outcomes.

At the same time, mathematics has been receiving better press. We see television programmes about it; it has

become more talked about, at least among certain groups, and is much more respected by the general public. There is recognition that mathematics is a useful subject, both in an every day sense and as a passport to higher earning careers. All this contributes to the bottom up by decisions by young people, advised by their parents and others, to consider studying mathematics at advanced level. There are many government figures summarising the data but in Figure 3 we show the numbers of persons entered for AL mathematics since 1996. These trends will continue at least until 2012 because the number of young people commencing AS mathematics in September 2010 is up again by about 8%.

The STEM Forum has not, of course, been in any way responsible for these improvements but our role has been to spread the news and to try and gauge what professionals on the ground think is possible. Our first involvement came when the Government decided to raise the target numbers for students studying AL mathematics (Discussion 22). The Government's 2014 target of 56,000 students taking GCE advanced level mathematics has been exceeded in 2008. They asked us to engage the community in discussion on raising the target for 2014 to 70,000. Our discussions came up with higher suggested figures: 80 000 to restore numbers to their pre year 2000 A Level changes; 89000 for parity with English, and even 100 000. No-one suggested a lower target. The Government decided to go with a target of 80000 and we believe the on-line discussion had an impact on this. It is interesting to note that on present projections this target will be met.

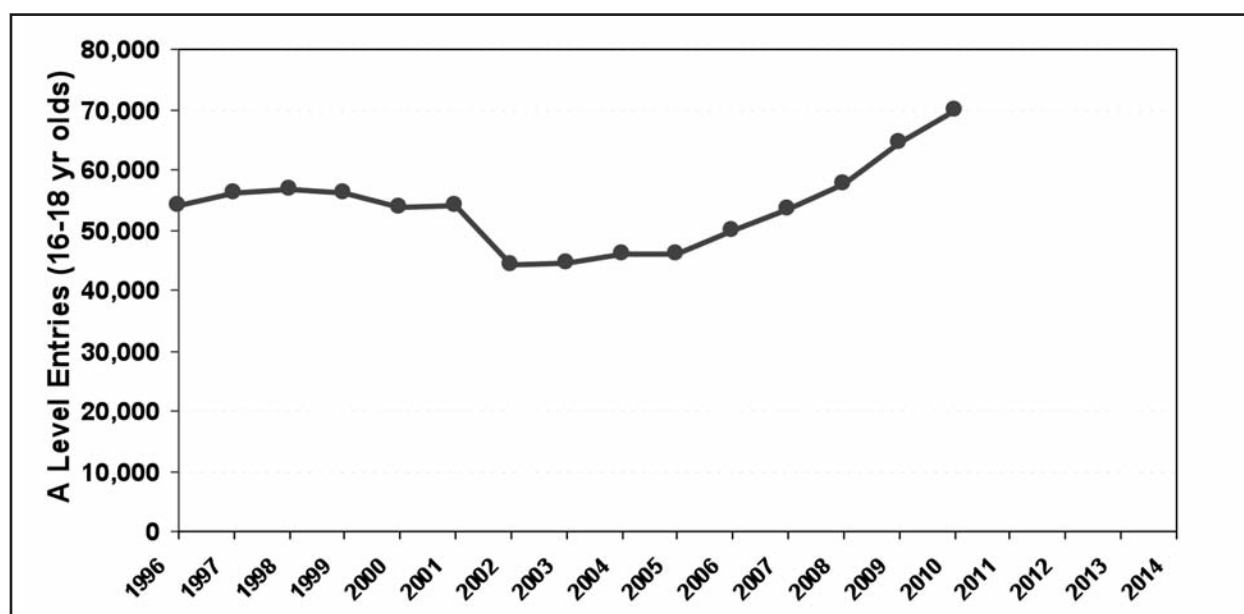


Figure 3.

## Invited Paper:

# The Stem Advisory Forum: A means of allowing people to influence the Government's STEM initiatives

**The prevalence of AL Mathematics in students admitted in 2009 and 2006 to read degrees in the UK (expressed as % of those admitted who had passed AL maths). The third column shows the % change between 2006 and 2009 (data analysed by Follett from UCAS numbers)**

Subject:	% in 2009	% in 2006	Rise +%	Subject:	% in 2009	% in 2006	Rise +%
Mathematics	99.5	99.0	+1	Economics	64.7	57.3	+13
Physics	96.1	94.5	+2	Accountancy +	55.0	45.6	+21
Engineering	80.3	73.1	+10	<b>Social studies</b>	<b>11.6</b>	<b>9.8</b>	<b>+18</b>
Medicine+	64.9	54.0	+20	- Geography (social)	15.7	12.8	+23
Chemistry	62.9	52.9	+19	- Business+	12.5	10.2	+22
Molecular biology	53.5	42.0	+27	- Law	12.1	10.2	+18
Pharmacy +	49.0	42.3	+16	- ITT (primary)	10.2	6.6	+55
Architecture	47.3	41.3	+14	- Hospitality/tourism	4.2	2.5	+69
Comp Sci	37.6	35.7	+5	- Media studies	2.8	2.6	+9
Geology	34.2	26.5	+29	<b>All humanities</b>	<b>8.8</b>	<b>7.0</b>	<b>+26</b>
Biology (all)	33.8	26.8	+26	- History	11.8	9.6	+23
Physiology+	30.4	19.8	+53	- English	6.7	5.6	+19
Geography (phys)	19.4	15.8	+22	- Music	19.6	14.3	+37
Psychology	11.2	8.9	+25	- Classics	19.4	16.2	+20
Nursing	7.5	5.9	+28	- Philosophy	15.0	13.4	+12
				- Euro languages	16.3	10.7	+52

Figure 4.

Perhaps of more value has been our involvement in bringing to university admission tutors the news about advanced level mathematics and trying to encourage them to reflect this in their preferred subjects for entry. A discussion has been held along with a face-to-face event plus visits to meetings of admission tutors. UCAS have been most helpful, in analysing the data which show that in 2009 just under a quarter of all entrants to UK universities (who study advanced levels) now offer a pass in mathematics as a component of their entry profile. A summary of the data is shown in Figure 4.

Many of the university stakeholders we have spoke with in England, Wales and Scotland, told us that there could well be implications for them in how they advertise courses and recruit students. Of course we cannot yet say precisely whether the Forum's activities will actually alter behaviour within the universities but it is an example of where such a Forum – unconnected to a specific academic subject – might be able to influence something of general importance.

### 3. Graduate supply

A second example of possible impact of the Forum, comes from our discussions on the supply of STEM graduates, both face to face and online, mainly with employers and also with people from universities. Employers were telling us that there is a shortage of home

grown STEM graduates and that they need to recruit from overseas, which carries with it disadvantages including financial ones. The conclusion was that an increase in the number of STEM places at university would help. The discussion led to a specific number and also a steer that any newly funded places should focus on the core sciences and mathematics. These outcomes were fed back to government and we like to think had some impact on a later decision. HEFCE did subsequently increase the numbers and by about the same as we had suggested, and broadly in the same areas (i.e. excluding medicine, psychology etc.).

### 4. Local and regional effects

Finally it is worth saying that the Forum has influence beyond government policy. The networking and discussion within the STEM community are of real value in terms of their impact on groups of learners. The most noticeable example of this comes from the event we ran for STEM Ambassadors and teachers in September 2010 in the National Space Centre at Leicester. The contact between those working in STEM jobs and school teachers spawned visits to classrooms from those in the field, and experiences for school teachers in the world outside the classroom, enabling them to bring a richer view to their lessons. This event was so successful that it will be repeated in York in 2011.

## Invited Paper:

# The Stem Advisory Forum: A means of allowing people to influence the Government's STEM initiatives

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